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1,079,580

PATENT SPECIFICATION

DRAWINGS ATTACHED

1079,580

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Int. Cl.: —F 16 b//F 16 d

COMPLETE SPECIFICATION

Fastener between a Rotary Driving Member and a Rotary Driven Member

We, ROTRON MANUFACTURING COMPANY INC., a corporation of the State of New York, of Hasbrouck Lane, Woodstock, New York, United States of America do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

In the assembly of parts of many devices, it is desirable to connect a rotary driving member and a surrounding rotary driven member with a predetermined force sufficient to hold them together for cooperative action but insufficient to cause undesirable strains in the members or in the connector. For example, when a number of connectors are used to connect two parts together, it is often desirable and sometimes important to provide a predetermined force on each connector so that each carries a particular design load and none carries an excessive or an ineffective load.

One way of obtaining the desired loading on conenctors is to use threaded fasteners such as bolts and to use a torque limiting tool to install them. One problem with this solution, however, is that the torque required to hold the members together at a predetermined force often varies from one bolt to another, thus requiring different torque wrenches or requiring resetting a single torque wrench. Moreover, friction between the bolt head face and the contacting face of the part and between the bolt threads and the threaded hole can vary significantly, depending upon such things as the nature of the material, the friction properties of surfaces of the bolt and the member, the presence of foreign material such as filings, oil or the like on the surfaces, and variations in fits. These and other problems make it difficult to provide a predetermined preload between two interconnected parts by turning down a threaded connector with a predetermined torque.

Another way of providing a predetermined holding force is to use a spring of some type between a connector and a member being fastened by the connector to another member. One problem with a spring arrangement is that a proper initial preload on the spring must still be provided, the preload being determined by the degree to which it is compressed, that is, by the position at which the connector holding the spring is stopped. Moreover, if the spring element is compressed to full load, that is, fully compressed, then there is a danger that it will act, not as a spring, but as a solid part by being turned down somewhat beyond the full spring load. Thus, there are significant disadvantages to utilizing springs to provide the predetermined preload between connected parts, one important disadvantage being that the spring load is determined by the initial compression of the spring which is in turn established by the position of the element holding it.

In accordance with the invention a fastening is provided between a rotary driving member and a surrounding rotary driven member which have radially outwardly extending slots in register with one another with the slot in the driving member deeper than that in the driven member, the fastening being provided by a connector which is connected to the driving member and movable towards the driving member to a secured position and a resilient washer which is trapped between a part of the connector and the members and which has a portion nesting in the slots to key the two members together, the arrangement being such that the washer initially engages the driven member at at least two first positions and subsequently, after flexing as the connector is moved towards the driving member

and reaches its secured position, engages the driven member at at least two second positions so that a sudden increase in flexural resistance is provided by the washer to further movement of the connector towards the driving member.

Preferably, the washer is initially curved, with its concave surface facing the rotary members and is substantially flat when, after flexing, it engages the driven member at the second positions, and is then unsupported radially inwards of the second positions.

Most conveniently, the washer is formed with tangs which serve both to engage the driven members at the first and second positions and to nest in the slots, keying the two members together. The tangs may then fit closely against the edges of the slots.

The tangs are preferably in diametrically opposite radially extending pairs and initially engage the driven member at the first positions with their tips and flex as the connector moves towards its secured positions until parts radially inward of the tips engage the driven member at the second positions.

A suitable kind of connector is one with a screw threaded shank and a head, the washer surrounding the shank and being trapped between the head and the rotary members.

One example of a member secured to a shaft by a fastening constructed in accordance with the invention is illustrated in the accompanying drawings, in which:

Figure 1 is an end view of the shaft and member;

Figure 2 is a section taken along the line 2—2 of Figure 1 and illustrating a resilient washer of the fastening in its initial shape and form;

Figure 3 is a view in section similar to Figure 2, but illustrating the resilient washer in its installed distorted position;

Figure 4 is a plan of the resilient washer; and,

Figure 5 is a side elevation of the resilient washer.

Referring to Figures 1 to 3, the fastening is shown connecting a driven member 10 to a rotary shaft 12. For example, the member 10 might be an impeller for a fan and the shaft 12 the shaft of a motor which drives the impeller.

One important reason for limiting the loading on a fastener is to prevent distortion or breakage of the parts being connected, particularly where the parts are delicate or where a distortion would impair their proper and efficient function. For example, in small rotary compressors requiring close face clearances, the impeller is carefully designed to provide optimum operation and deformation cannot be tolerated. Thus, it is desirable to provide a predetermined loading of the fastener which connects the impeller to the motor shaft, so that distortion beyond that which may be accounted for in the design is avoided.

The body of the member 10 is provided with a bore 14 which receives the end of the shaft 12, and recessed slots 16 are formed in the outside face 10′ of the member 10 at diametrically opposite points with respect to the bore 14. The member 10 is installed on the shaft and bears against a snap ring 18 on the shaft, the snap ring 18 being received in a groove 20 formed about the periphery of the shaft. When so installed, the outside face 10′ of the member 10 is flush with the outer end 12′ of the shaft 12.

A circular recess 22 is formed in the centre of the shaft 20 to a depth somewhat greater than the depth of the slots 16 in the driven member 10, and extending outwardly from the central recess 22 at diametrically opposite points are slots 24 which are of substantially the same depth as the central recess 22. The width of the slots 24 are approximately the same as the widths of the slots 16 in the member 10.

The member 10 is connected to the shaft 12 and held thereon by a screw 28 threaded axially into the end of the shaft 12 and inserted through a resilient washer 30. As particularly shown in Figures 4 and 5, the washer 30 includes a body portion 32 which is provided with a hole 34 for receiving a shank 28*b* of the bolt 28 and has a diameter slightly less than that of the circular recess 22 in the end of the shaft 12 so that it may be received in the recess 22. As best shown in Figure 1, the body portion of the washer is also generally coextensive with the lower face of the head 28*a* of the screw. Formed integrally with and extending outwardly in diametrically opposite directions from the body portion of the washer are tangs 36 which are of generally rectangular shape in plan. The washer 30, as best illustrated in Figure 2 and 5, is formed with an initial curvature.

As shown in Figures 1 to 3, the outer ends of the tangs 36 of the washer 30 are received in the slots 16 of the member 10, the body portion 32 is received in the circular recess 22 of the shaft 12, and the innermost portions of the tangs 36 are received in the radially extending slots 24 in the end of the shaft.

The fastener is installed and operates in the following manner. After the member 10 is placed on the shaft and the shaft slots 24 aligned with the slots 16 in the member 10, the washer 30 is placed in position in the aligned slots and recess with its concave surface facing the bases of the recess and slots. The screw is then started and turned down into the threaded hole in the shaft, such as by a manual screw driver. As shown in Figure 2, the outermost ends of the tangs 36 then engage the bases of the slots 16 in the driven member 10 as the screw is turned in until and for a predetermined increment of move-

ment after the head of the screw 28 contacts the body portion 32 of the washer 30. At this time, the washer spans a distance A in Figure 2, the distance A being between the outermost ends of the tangs 36. (The distance A increases slightly as the washer is flattened out).

As will be understood, the washer 30 operates in a fashion similar to a beam which is simply supported at opposite ends, the load being provided by the resilience of the washer and acting upwardly against the head 28a of the bolt 28 and downwardly at the outer ends of the tangs 36 against the bases of the slots 16. As the screw is turned down into the threaded hole 26 of the shaft 12, the force resisting the movement of the screw 28 is gradually increased by the increasing strain as the washer is flattened out, and reaches a maximum just before the washer 30 flattens completely, as illustrated in Figure 3. At that maximum point, the washer is still supported across the span distance A. When the bolt is turned a little bit further, it passes through a brief transition in which the ends of the tang 36 are supported across a relatively broad area by the bases of the slots 16, and then immediately, the washer element 30 becomes supported, not at the outer ends of the tangs 36, but at points thereon a distance substantially inwardly of the ends where the tangs engage the innermost edges 16a of the bases of the slots 16, that is, where the bases of the slots 16 intersect the bore 14.

It will be noted that the distance spanned by the washer 30 is thus substantially reduced from the distance A to the distance B in Figure 3. The decrease in the span from the distance A to the distance B results in a considerable relative increase in the force exerted by the resilient washer, and thus produces a substantial increase in the amount of turning force required to turn down the screw 28 further into the shaft. The increase in turning force is very marked and is readily sensed by the person turning the screw driver. The increase thus constitutes a well defined signal to that person that the desired preload of the member 10 axially onto the shaft 12 has been obtained. This force is, of course, determined by the design of the washer 30, and particularly by the properties and thickness of the material used and by the dimensions of the washer between the points at which the tangs 36 engage the inner edges 16a of the slots 16.

In the illustrated example it should be noted that the washer element 32 not only functions as a preload device for holding the driven member 10 on the shaft 12 with a predetermined force but also acts as a key positively to couple the shaft to the driven member for joint rotation. Similarly keying arrangements can be utilized to provide a proper registration or relative positioning between any types of members being connected by the fastening of the invention.

While in the illustrated example, the fastener is completely recessed below the outer surfaces of the respective members being connected, it will be understood that the connector and washer may engage the outer face of a member being connected to another member. For example, a member having a flat surface can be connected to another member by providing a slight recess such as a spot face, in the flat surface so that edges are provided for engagement by points inwardly of the ends of the washer element but outwardly of the connector head.

It is important for the proper operation of the fastener that the washer be arranged so that no portion of the washer which lies inwardly of an engaging part of the connector, such as the head of the screw or bolt, engages the members being connected together. If any part of the washer which positively engages the surface of the member being connected is coextensive with and in contact with the underside of the connector head, then there is a danger that the connector will be moved too far and that a load beyond the resilient load provided by the washer will be produced. Preferably, the points on the member engaged by the washer when it is in the desired position should lie a fairly substantial distance outwardly of the head of the connector, thereby limiting the effect of any slight movement of the connector toward the element to which it is secured beyond the desired point.

On the above-described use for connecting a compressor impeller to a shaft, the fastener of the invention makes it possible to provide a predetermined loading, and particularly a loading which is below that which might cause excessive heating, wear or failure of an adjacent shaft bearing, to eliminate clearance between the impeller and the shaft bearing and to provide accurate location of the impeller on the shaft. Moreover, recessing the fastener, as shown in the drawings reduces overall length and yet provides maximum shaft bore engagement. The fastener eliminates the costly and time-consuming machining and threading operations necessary for a conventional keyed mounting. Further, the fastener provides a large torque-transmitting radius. The pre-loading of the impeller on the shaft prevents vibration and induced movements which tend to cause fretting at the adjacent surfaces.

The washer may be of many different shapes, in addition to the configuration illustrated in the drawings; for example, it could be entirely circular or could be provided with several tangs. In addition, the washer element need not be symmetrical about the axis of the connector. The surface of the member which is engaged by the washer may include a central recess, as described previously, or

an outer groove or boss which is engaged by a part of the washer member.

Moreover, the washer might be formed initially as a flat member and resiliently deflected to have a curvature when completely installed. As in the case of the illustrated embodiment wherein the washer is initially curved and then flattened during installation, this form of the invention would also provide a positive torque increase indication to the installer when the span of the points of contact, such as provided by suitably stepped surface, decreases substantially. It would, of course, also provide all of the other advantages of the construction shown in the drawings.

The connectors need not be screw threaded and may, for example be of a press-in type.

WHAT WE CLAIM IS:—

1. A fastening between a rotary driving member and a surrounding rotary driven member which have radially outwardly extending slots in register with one another with the slot in the driving member deeper than that in the driven member, the fastening being provided by a connector which is connected to the driving member and movable towards the driving member to a secured position and a resilient washer which is trapped between a part of the connector and the members and which has a portion nesting in the slots to key the two members together, the arrangement being such that the washer initially engages the driven member at at least two first positions and subsequently, after flexing as the connector is moved towards the driving member and reaches its secured position, engages the driven member at at least two second positions which are closer to one another than are the first positions so that a sudden increase in flexural resistance is provided by the washer to further movement of the connector towards the driving member.

2. A fastening according to claim 1, in which the washer is initially curved, with its concave surface facing the rotary members and is substantially flat when, after flexing, it engages the driven member at the second positions, and is then unsupported radially inwards of the second positions.

3. A fastening according to claim 1 or to claim 2, in which the washer is formed with tangs which serve both to engage the driven member at the first and second positions and to nest in the slots, keying the two members together.

4. A fastening according to claim 3, in which the tangs fit closely against the edges of the slots.

5. A fastening according to claim 3 or to claim 4, in which the tangs are in diametrically opposite radially extending pairs and initially engage the driven member at the first positions with their tips and flex as the connector moves towards its secured position until parts radially inward of the tips engage the driven member at the second positions.

6. A fastening according to any preceding claim, in which the connector has a screw threaded shank and a head and the washer surrounds the shank of the screw and is trapped between the head and the rotary members.

7. A fastening according to any one of the preceding claims in which the driving member is a shaft and the driven member is a fan impeller,

8. A fastening according to claim 1, substantially as described with reference to the accompanying drawings.

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1079580 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

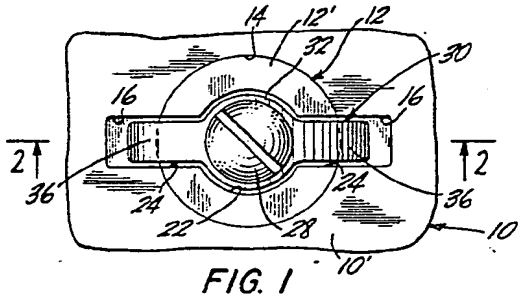

FIG. 1

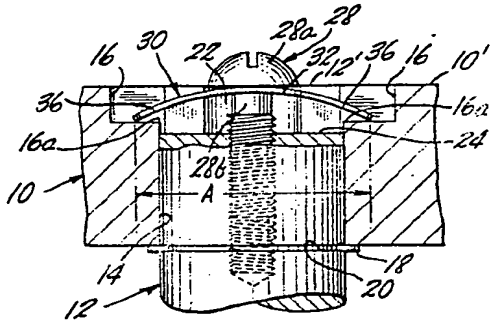

FIG. 2

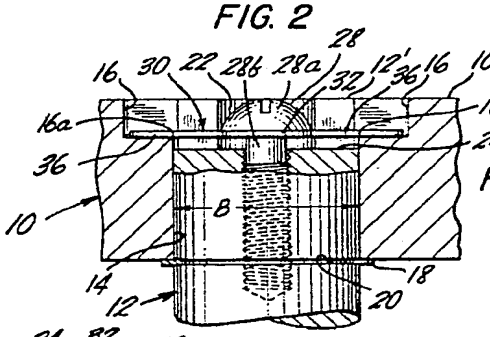

FIG. 3

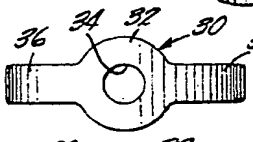

FIG. 4

FIG. 5